INSTRUCTION BOOK

DIVERSITY COMBINER

TYPE 234 MODEL 2C

MP MASTER
MA23768

NORTHERN RADIO
MANUFACTURING COMPANY LIMITED
1950 BANK STREET, OTTAWA, CANADA

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TABLE OF CONTENTS

Part	Title	Page
1	GENERAL DESCRIPTION	1
	Purpose of Equipment	1
	Description	1
	Technical Data	2
2	PRINCIPLES OF OPERATION	3
	Dual Diversity Operation (2 channel)	3
	Quadruple Diversity Operation (4 channel)	4
3	OPERATING INSTRUCTIONS	5
	Description of Controls	5
	Initial Adjustments	5
4	MAINTENANCE INSTRUCTIONS	7
	Table of Voltage Measurements	8
5	ELECTRICAL PARTS LIST	9
6	ILLUSTRATIONS	13-14

LIST OF ILLUSTRATIONS

Fig.	Title	Page
1	Diversity System Functional Block Diagram	13-14
2	Diversity Combiner Type 234 Model 2C, Component Mounting Board	15-16
3	Diversity Combiner Type 234 Model 2C, Schematic Diagram	17-18

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PART 1

GENERAL DESCRIPTION

PURPOSE OF EQUIPMENT

1 The Northern Radio Diversity Combiner Type 234 Model 2C is used in telegraph communication circuits which are subject to variation in attenuation, such as point-to-point radio circuits, to improve the reliability of reception.

2 The combiner is located at the receiving end of a circuit as part of a diversity receiving system, where it is used in conjunction with two Northern Radio Frequency Shift Converters Type 212. The combiner will select the better of the two signals containing the same intelligence, in order that the output from the two converters will be the output of the better channel. The combiner has provision for coupling 2 combiners and 4 converters for quadruple diversity operation.

DESCRIPTION

3 The Diversity Combiner is a completely transistorized unit contained in a 1-7/8" x 5-1/4" x 11-3/4" chassis. It will continuously compare the levels of two signals applied to its two inputs and produce two output control signals. The amplitude of the control signal is determined by the relative amplitude of the incoming signal.

4 The actual combining of the two signals is done at the output of the discriminators, which are connected in parallel. The combined signal is passed to the common low pass filter terminating circuit. This method of combination has no time constants of its own and it is therefore instantaneous. The Diversity Combiner accentuates any level difference that exists between the two signals, by applying a higher collector voltage to the final limiting amplifier in the converter, with the higher signal and reducing the one with the lower signal. Thus the stronger signal dominates and the weaker one is suppressed.

5 The combiner uses novel means in order to obtain effective diversity action over a wide dynamic operating range. Signal amplification is combined with semi-logarithmic compression to provide a control voltage effective over a 60 db range of input signal level variation. Furthermore, the control voltage variation is approximately the same for a given db difference in the signal levels without regard to their actual strengths. The end result of this action is that the diversity action is as good at low signal levels (where it is needed), as it normally is at high signal levels.

6 The use of transistors throughout this unit results in a device which is more compact, more reliable and far more effective than has been previously possible. Internal heat in the unit is negligible and any required number of units may be mounted in close proximity to each other without fear that excessive temperature rises will occur due to heat dissipation.

TECHNICAL DATA

7	Frequency Range:	300 cps to 10 kc.
	Signal Levels:	0 dbm to -60 dbm at input of Type 212 Model 4 converter.
	Output Control Voltage:	Differential voltage control to push-pull limiter in Type 212 converters.
	Control Sensitivity:	Effective over entire signal level range of 0 dbm to -60 dbm.
	Diversity Switching Method:	Limiter output control.
	Controls:	Signal Balance (on front panel) Sensitivity
	Power Requirements:	14 volts dc, 30 ma.
	Dimensions:	1-7/8" wide x 5-1/4" high x 11-3/4" deep. (For rack mounting a number of these or similar units, a shelf assembly is available accommodating 9 units in a panel height of 5-1/4".)
	Weight:	1-1/2 lb.

PART 2

PRINCIPLES OF OPERATION

DUAL DIVERSITY OPERATION (2 CHANNEL)

1 To obtain a complete understanding of the operation of the Diversity Combiner, the diversity action must be studied in conjunction with the associated converters. The functional diagram is illustrated in figure 1.

2 The diversity system as illustrated in figure 1, employs two converters designated "A" and "B" for purposes of this description, and one Diversity Combiner. The signals in the two converters are sampled after the first amplifier in each converter. These two signals are passed through two amplifiers which are adjusted to have the same gain. The outputs from the two amplifiers are rectified and applied to a dc differential amplifier.

3 The output of the differential amplifier controls the supply voltage to the discriminator driving amplifier in the two converters, in such a way that the converter with the stronger signal is turned ON and the converter with the weaker signal is turned OFF.

4 The "A" converter only is equipped with an output relay. The output of the discriminators in both the "A" and the "B" converters are connected to the dc amplifier in the "A" converter to drive the output relay. The dc amplifier in the "B" is inoperative. The schematic diagram of the Diversity Combiner is shown in figure 3.

5 The input amplifiers are in push-pull configuration and consist of Q1-Q2 and Q3-Q4 for the "A" and "B" converters respectively.

6 Q6 and Q7 from a dc differential amplifier, the emitters of which are supplied by a constant current source, Q5. Note that the connection between the collector of Q5 and the emitters of Q6-Q7 is through an external strapping. This arrangement is provided to cater for quadruple diversity operation. For dual diversity the connection is completed externally between pins 3 and 10 of the main connector.

7 The amplifier input signals are rectified and applied independently to the bases of Q6 and Q7. The one with the higher signal will drive its associated transistor into conduction and the opposite one towards cutoff. Thus the collector of the transistor having the greater signal applied will fall towards positive rail and the opposite one will rise. Assuming that channel 1 has the greater signal, Q6 will be driven into conduction and its collector voltage will fall, turning off Q9. The collector of Q9 will therefore rise towards negative rail, turning on Q11, which turns on the supply to the discriminator driving amplifier in the "A" converter. Simultaneously, Q7 will tend to cut off, its collector will rise, turning on Q10. Q10 collector will therefore fall and turn off Q12, thus removing the supply to the discriminator driving amplifier in the "B" converter.

8 When both channels have equal signals applied to them Q6 and Q7 remain in the substantially zero signal condition in which they are biased approximately half way between cut-off and full conduction. In this case Q11 and Q12 are likewise approximately at the mid point of their conducting range so that both the channel "A" and the channel "B" converters contribute to the output signal.

9 In order that equal signals produce equal outputs it is essential that the two input amplifiers have equal gain and that the balance control of the differential amplifier Q6-Q7 be correctly adjusted. The gains of the two input amplifiers are individually adjusted by means of R4 and R8 respectively. Reducing the value of the resistance between the emitters of the amplifiers will increase the gain. For maximum sensitivity, the gain should be as high as can be obtained compatible with stability and equalization. Since the rectified output of both amplifiers is negative with respect to the fixed bias point, J2, connecting a voltmeter between J1 and J3, and adjusting the gain controls for a "null" when identical signals are applied to the two amplifiers, will ensure that gain equalization is obtained.

10 The equalization adjustment is carried out at the factory and it should not be necessary to touch this adjustment in the field unless replacement of components has been necessary.

11 The adjustment of the balance and sensitivity controls is covered in the section on Initial Adjustments.

12 At the point in the converter where the signal is picked off, there is no limiting at very low level signals, but as signal strength increases semi-logarithmic compression occurs owing to the characteristics of the germanium diodes in the converter, which substantially squares off high level signals by limiting action. The diversity action is effective over a dynamic range of about 60 db; due to the compression, less signal differential is required to effect diversity action at low level signals (where it is needed) than is required at high level signals. The circuit has no built-in time constant. The circuit therefore is very fast and capable of accepting rapid fades.

QUADRUPLE DIVERSITY OPERATION (4 CHANNEL)

13 When quadruple diversity operation is required, four Type 212 converters and two combiners are employed. In this case the Q6-Q7 transistors of both combiners receive emitter current from the Q5 transistor of only one of the combiners. With this arrangement, the strongest of the four signals involved will predominate in supplying high, negative voltage, back to the final limiting amplifier of the converter from which the signal comes.

14 As in the case of the dual diversity, the outputs of all discriminators are connected to the dc differential amplifier of the converter in the group which is equipped with an output relay.

PART 3

OPERATING INSTRUCTIONS

DESCRIPTION OF CONTROLS

Input Amplifier Gain Controls R4 and R8

1 The gain controls are multi-turn variable resistors with screwdriver adjustments, accessible through the top of the chassis (toward the rear). The controls are preset and should not require attention during setting up.

Sensitivity Control, R15

2 The sensitivity control is a single turn, screwdriver adjusted, variable resistor, accessible through the front panel. It controls the gain of the dc differential amplifier.

Balance Control, R18

3 The balance control is a single turn, screwdriver adjusted, variable resistor, accessible through the front panel. Its function is to compensate for differences in gain between Q6 and Q7.

Diversity Combiner Shelf

4 The diversity combiner is used in association with two, Frequency Shift Converters Type 212, as a part of a Diversity Receiving System. Three groups, each consisting of two converters and one combiner, normally occupy one Diversity Combiner Shelf Type 1284. The shelf is wired to provide the necessary interconnections between the various units.

5 Since each system will have its own particular rack assembly and grouping, connections to the shelf will be found in the instruction manual relating to the system. The wiring shown in figure 1 can be considered typical wiring for a Dual Diversity System.

INITIAL ADJUSTMENTS

6 With the combiner installed in a shelf which is wired into the telegraph system, it is necessary to ensure that the unit is properly adjusted and operating correctly. With the operating power and signals applied to the shelf, the combiner should be checked and adjusted. In carrying out these adjustments it is important that the following conditions be established:

(1) Signals of identical strength must be applied to both converters. This can be done by temporarily patching the same signal into both converters.

INITIAL ADJUSTMENTS (Cont'd)

(2) The signal level should be in the region where the most critical diversity action is desired. -50 dbm is generally suitable, but a higher level may be used if desired.

Having established these conditions proceed as follows:

(3) Using a small screwdriver, turn the SENsitivity control in a clockwise direction until meter M1 or M2 reaches maximum reading. Turn the BALance control until M1 and M2 give equal reading. If a satisfactory balance cannot be obtained repeat the operation in sub paragraph (1), with a different setting of the balance control.

(4) Readjust the SENsitivity control until both M1 and M2 are indicating approximately one half of the previously observed maximum reading.

(5) Test for diversity action of the combiner by loosening the thumbscrews holding associated converters and partly withdrawing first one converter, and then the other. Meter M1 should drop to near zero scale and M2 should approach full scale when the channel 1 converter is removed, and M2 should drop to near zero and M1 approach full scale when the channel 2 converter is removed.

PART 4

MAINTENANCE INSTRUCTIONS

GENERAL

1 Since the combiner employs long-life reliable semiconductor elements as amplifier and rectifier units, and since very little heat is generated in the operating device, it is anticipated that maintenance requirements will be minimized. In the event of malfunction, it is recommended that the difficulty be positively associated with the combiner by the process of temporarily substituting a different combiner in the shelf. If the substituted combiner functions properly, then it may be assumed that the difficulty was in the original unit. In such case, the difficulty may be localized in either the amplifier, rectifier, or differential amplifier sections of the combiner by the use of a vacuum tube or other high resistance voltmeter. The voltage readings should be made at the appropriate test point jacks on the front panel. The rectified dc voltage from the channel amplifier appears across J1 and J2, while the voltage of the channel 2 amplifier appears across J2 and J3. This voltage will be a fraction of a volt for low level signals and a maximum of 1.2 volts for large signals. The essential thing is that equal input signals should produce equal dc voltages. Since the voltages at both J1 and J3 are negative with respect to J2, exact balance is indicated when the voltage between J1 and J3 is zero when equal input signals are applied.

2 Temporary removal of either associated converter will confirm the operation or non-operation of each channel amplifier and associated rectifier. If the amplifiers and rectifiers are in good condition the difficulty is obviously in the differential amplifier and dc output stages. Further testing should be carried out at the test bench. Voltage measurements of appropriate circuit points may be made most easily by inserting one voltmeter probe into J5 test jack and touching the wire leads of appropriate components on the printed circuit board. Figure 2 is a layout drawing, indicating the physical location of all components on the board. Use of this drawing in connection with the schematic diagram, figure 3, and the Table of Voltage Measurements, will enable any troubles to be localized.

3 In the infrequent instances when it is necessary to remove and replace components on the printed circuit board, it is recommended that an appropriate small soldering iron with limited heat storage be employed.

Circuit Symbol	Input *	Emitter	Base	Collector	Circuit Symbol	Input	Emitter	Base	Collector
Q1	A	0.54	0.66	13.2	Q7	A	1.9	1.3	4.3
	B	0.03	0.12	13.2		B	2.1	2.3	2.2
	C	0.05	0.15	13.2		C	1.1	1.3	3.3
Q2	A	0.54	0.66	13.2	Q8	A	1.1	1.3	9.2
	B	0.03	0.12	13.2		B	1.1	1.3	9.2
	C	0.05	0.15	13.2		C	1.1	1.3	9.2
Q3	A	0.06	0.16	13.2	Q9	A	1.0	1.1	11.0
	B	0.54	0.66	13.2		B	1.0	1.1	13.2
	C	0.05	0.15	13.2		C	1.4	1.6	7.8
Q4	A	0.06	0.16	13.2	Q10	A	1.7	1.9	1.8
	B	0.54	0.66	13.2		B	1.0	1.1	13.2
	C	0.05	0.16	13.2		C	1.4	1.6	7.8
Q5	A	0.50	0.65	1.8	Q11	A	10.6	10.8	11.8
	B	0.50	0.65	1.8		B	1.7	1.9	13.2
	C	0.50	0.65	1.0		C	7.6	7.8	13.2
Q6	A	2.1	2.3	2.2	Q12	A	1.7	1.9	13.2
	B	1.9	1.3	4.3		B	13.0	13.2	13.2
	C	1.1	1.3	3.3		C	7.6	7.8	13.2

Table of Voltage Measurements

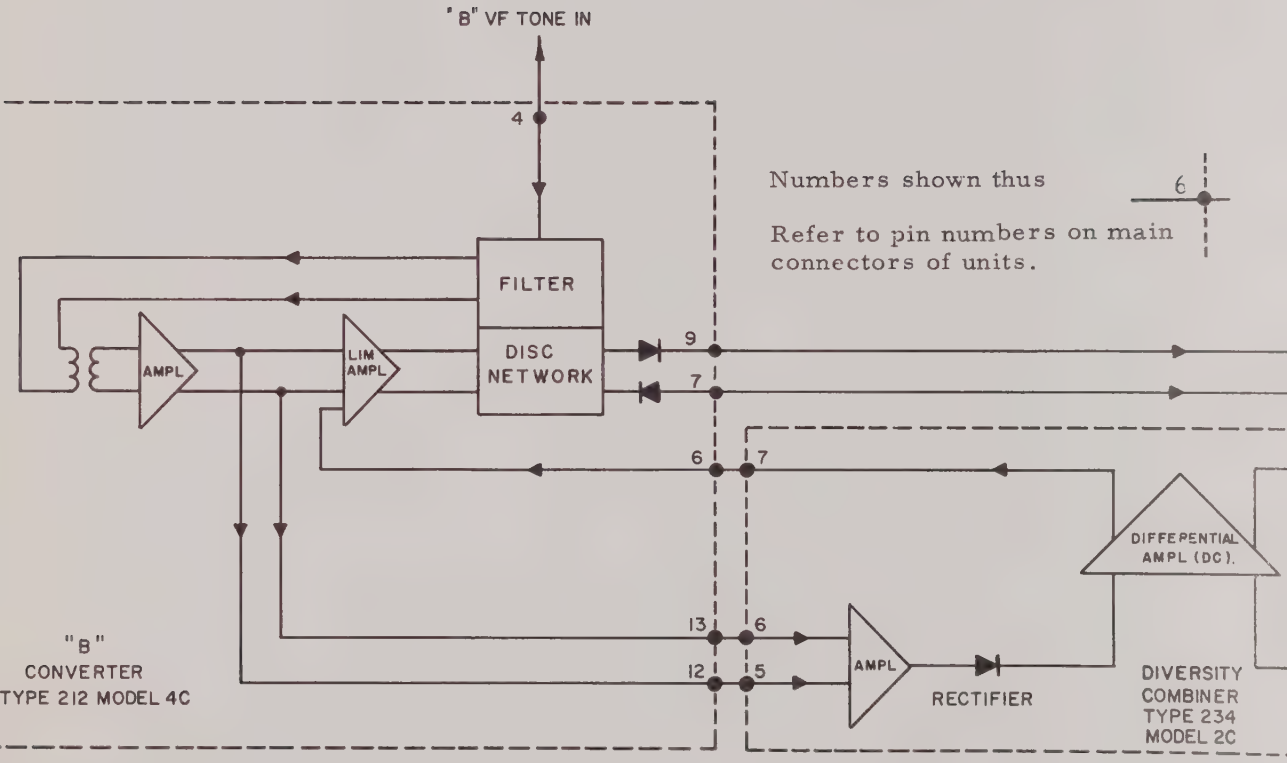
*Input column refers to: A channel No. 1 ON
B channel No. 2 ON
C -20 dbm to both inputs

All voltages listed may vary ± 15%. Readings taken with a high impedance VTVM.

Circuit Symbol	Function	Description	Mfr.	Part No.
C1	CHAN No. 1 compensator	CAPACITOR, FIXED: ceramic disc, 0.5 uf ± 80% -30%, 75v	CEN	DDA-503
C2	CHAN No. 2 compensator	SAME AS C1		
C3	CHAN No. 1 signal filter	CAPACITOR, FIXED: ceramic disc, 2.2 uf, 3v	CEN	UK-225
C4	CHAN No. 2 signal filter	SAME AS C3		
C5	Q11 base filter	CAPACITOR, FIXED: ceramic disc, 0.1 uf +80% -30%, 75v	CEN	DDA-104
C6	Q12 base filter	SAME AS C5		
CR1	CHAN No. 1 signal rectifier	SEMICONDUCTOR DEVICE: (DIODE) germanium type	ANY	1N34A
CR2	CHAN No. 1 signal rectifier	SAME AS CR1		
CR3	CHAN No. 2 signal rectifier	SAME AS CR1		
CR4	CHAN No. 2 signal rectifier	SAME AS CR1		
CR5	Q6, Q7, Q8 base bias	SEMICONDUCTOR DEVICE: (DIODE) silicon type	ANY	1N457
CR6	Q5 base bias	SAME AS CR5		
CR7	Voltage regulator	SEMICONDUCTOR DEVICE: Zener diode, silicon type	ANY	1N754A
J1	CHAN No. 1 rectifier test point	CONNECTOR, RECEPTACLE: single conductor, white plastic base	EFJ	105-251-1
J2	Rectifier common test point	SAME AS J1		
J3	CHAN No. 2 rectifier test point	SAME AS J1		
J4	Negative rail test point	CONNECTOR, RECEPTACLE: single conductor, black plastic base	EFJ	105-251-3
J5	Positive rail test point	CONNECTOR, RECEPTACLE: single conductor, red plastic base	EFJ	105-251-2
J6	Input and output connections	CONNECTOR, PLUG: 14 conductor	AMP	57-10140
M1	CHAN No. 1 signal level indicator	METER: 0-1 ma, 1 inch dia panel mtg	INI	100C
M2	CHAN No. 2 signal level indicator	SAME AS M1		
Q1	CHAN No. 1 signal ampl.	SEMICONDUCTOR DEVICE: germanium transistor, PNP junction	MOT	2N652A
Q2	CHAN No. 1 signal ampl.	SAME AS Q1		
Q3	CHAN No. 2 signal ampl.	SAME AS Q1		
Q4	CHAN No. 2 signal ampl.	SAME AS Q1		
Q5	Q6, Q7 current control	SAME AS Q1		
Q6	1st differential ampl.	SAME AS Q1		
Q7	2nd differential ampl.	SAME AS Q1		
Q8	Q9, Q10 emitter voltage regulator	SAME AS Q1		

Circuit Symbol	Function	Description	Mfr.	Part No.
Q9	CHAN No. 1 control ampl.	SAME AS Q1		
Q10	CHAN No. 2 control ampl.	SAME AS Q1		
Q11	CHAN No. 1 output control ampl.	SAME AS Q1		
Q12	CHAN No. 2 output control ampl.	SAME AS Q1		
R1	Q1 emitter	RESISTOR, FIXED: Hi-stab carbon, 464 ohm ± 1%, 1/4w	WYN	C11
R2	Q2 emitter	SAME AS R1		
R3	Q1, Q2 coupling	RESISTOR, FIXED: composition, 100 ohm ± 10%, 1/2w	ANY	
R4	CHAN No. 1 gain adjustment	RESISTOR, VARIABLE: wirewound, 500 ohm ± 20%, 1/3w	BLI	275-1-501
R5	Q3 emitter	SAME AS R1		
R6	Q4 emitter	SAME AS R1		
R7	Q3, Q4 coupling	SAME AS R3		
R8	CHAN No. 2 gain adjustment	SAME AS R4		
R9	CHAN No. 1 compensation	RESISTOR, FIXED: composition, 10K ohm ± 10%, 1/2w	ANY	
R10	CHAN No. 2 compensation	SAME AS R9		
R11	CR1, CR2 load	RESISTOR, FIXED: composition, 1.5K ohm ± 10%, 1/2w	ANY	
R12	CR3, CR4 load	SAME AS R11		
R13	CR5, CR6 series	RESISTOR, FIXED: composition, 4.7K ohm ± 10%, 1/2w	ANY	
R14	Q5 emitter	RESISTOR, FIXED: composition, 390 ohm ± 10%, 1/2w	ANY	
R15	Sensitivity control	RESISTOR, VARIABLE: composition, 500 ohm ± 20%, 1/3w	PEC	PSU 5012-S12
R16	Q6 emitter	RESISTOR, FIXED: Hi-stab carbon, 316 ohm ± 1%, 1/4w	WYN	C11
R17	Q7 emitter	SAME AS R16		
R18	Q6, Q7 coupling	RESISTOR, VARIABLE: composition, 100 ohm ± 20%, 1/3w	PEC	PSU 1012-S12
R19	Q6 collector	RESISTOR, FIXED: Hi-stab carbon, 5.11 ohm ± 1%, 1/4w	WYN	C11
R20	Q7 collector	SAME AS R19		
R21	CR7 series	RESISTOR, FIXED: composition, 1K ohm ± 10%, 1/2w	ANY	
R22	Q8, Q9, Q10 common emitter	RESISTOR, FIXED: composition, 220 ohm ± 10%, 1/2w	ANY	
R23	Q8 collector	SAME AS R11		
R24	Q6, Q9 coupling	SAME AS R19		
R25	Q7, Q10 coupling	SAME AS R19		
R26	Q9 base shunt	SAME AS R19		
R27	Q10 base shunt	SAME AS R19		
R28	Q9 emitter	RESISTOR, FIXED: Hi-stab carbon, 287 ohm ± 1%, 1/4w	WYN	C11
R29	Q10 emitter	SAME AS R28		
R30	Q9 emitter	SAME AS R19		
R31	Q10 collector	SAME AS R19		
R32	Q11 collector	SAME AS R3		

Circuit Symbol	Function	Description	Mfr.	Part No.
R33	Q12 collector	SAME AS R3		
R34	M1 series	RESISTOR, FIXED: Hi-stab carbon, 14.7K ohm ± 1%, 1/4w	WYN	C11
R35	M2 series	SAME AS R34		
R36	J4 isolation	SAME AS R9		
T1	CHAN No. 1 input coupling	TRANSFORMER, AUDIO: miniature type. Pri: 1.5K ohm ct Sec: 10K ohm ct	NRM	1012P
T2	CHAN No. 2 input coupling	SAME AS T1		


"B" VF TONE IN
4
Numbers shown thus
6
Refer to pin numbers on main connectors of units.
FILTER
DISC NETWORK
AMPL
LIM AMPL
9
7
6
7
DIFFERENTIAL AMPL (DC).
13
6
12
5
AMPL
RECTIFIER
"B" CONVERTER TYPE 212 MODEL 4C
DIVERSITY COMBINER TYPE 234 MODEL 2C

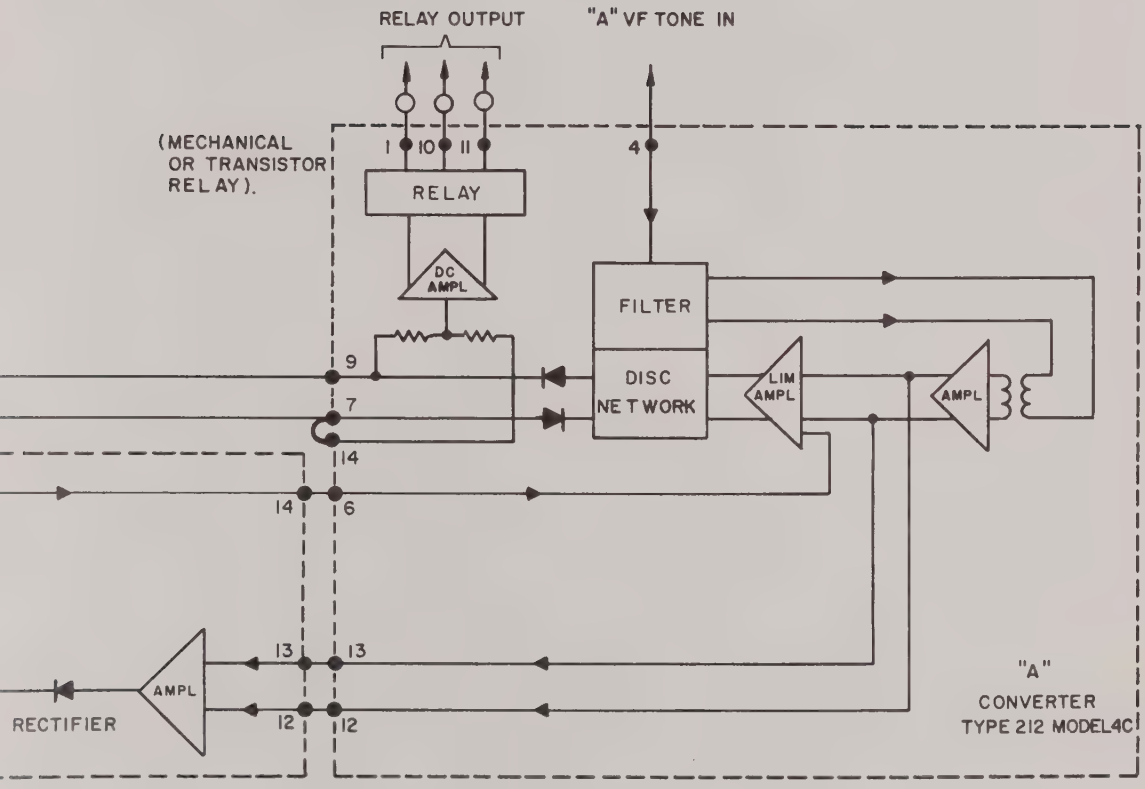


Figure 1 Diversity Combiner Type 234 Model 2C, Diversity System Functional Block Diagram

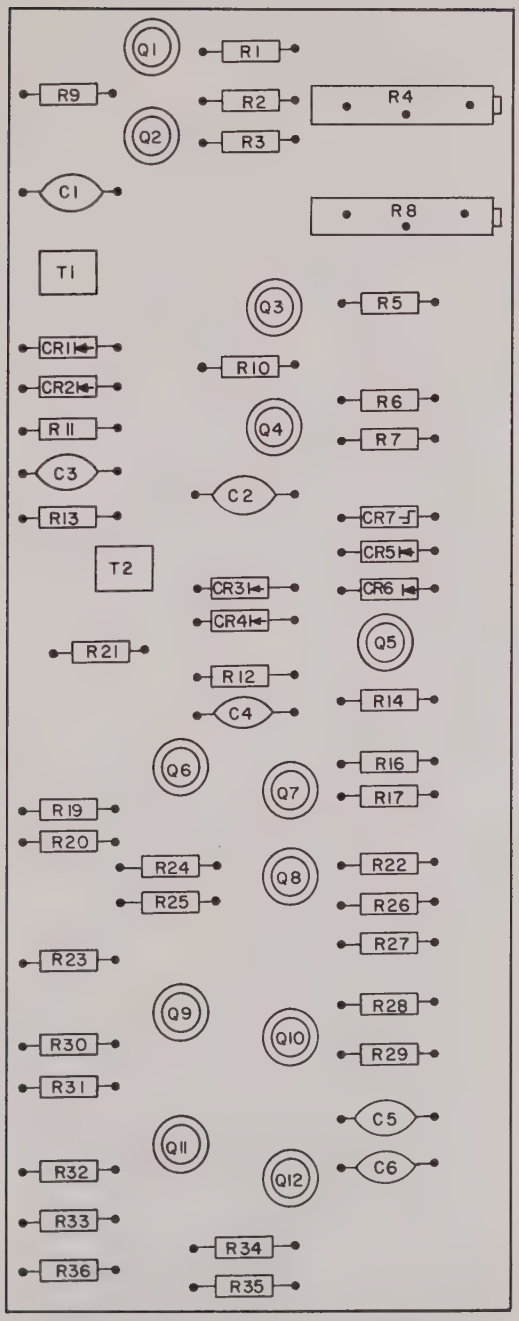


Figure 2 Diversity Combiner Type 234 Model 2C, Component Mounting Board

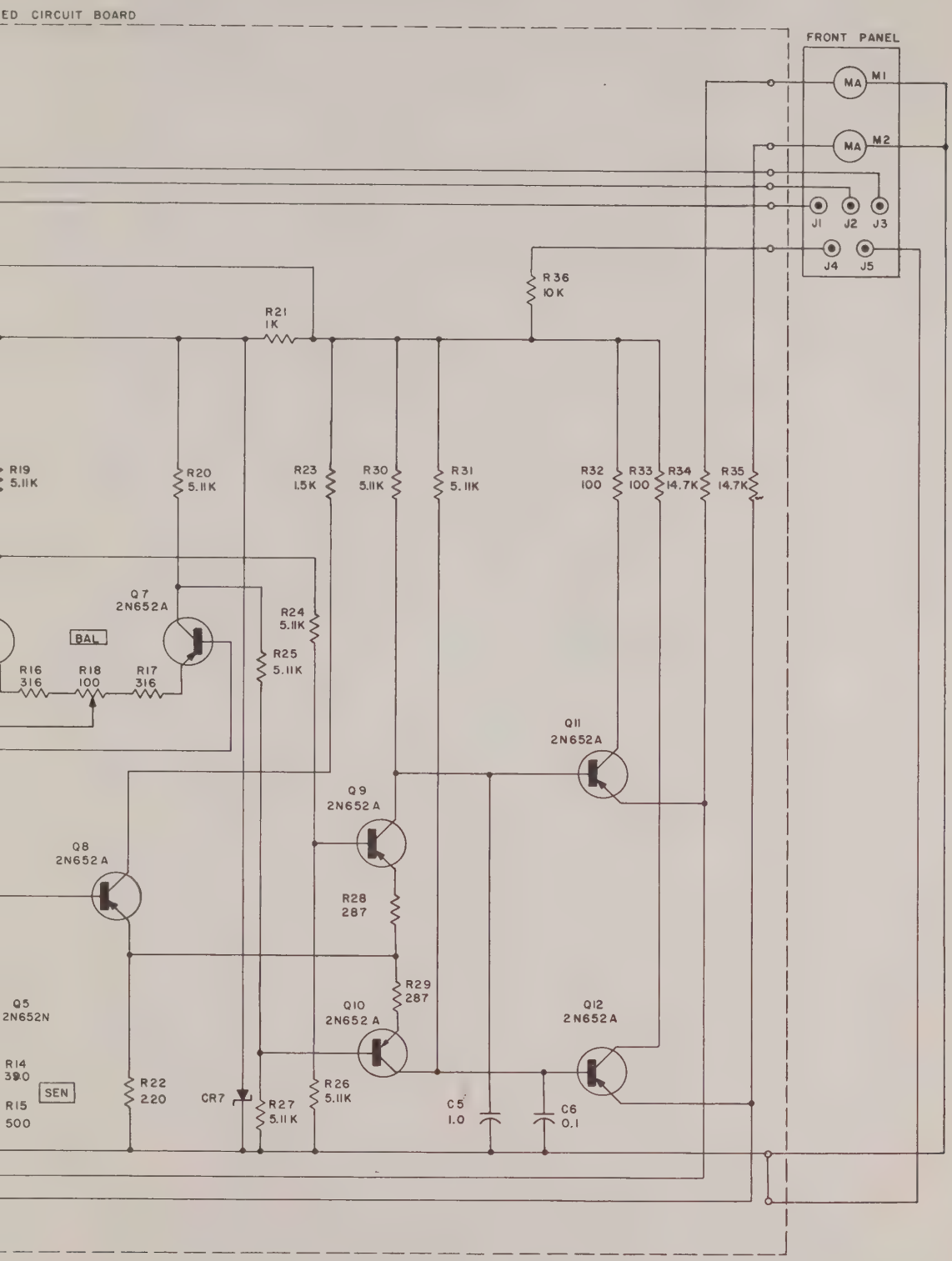
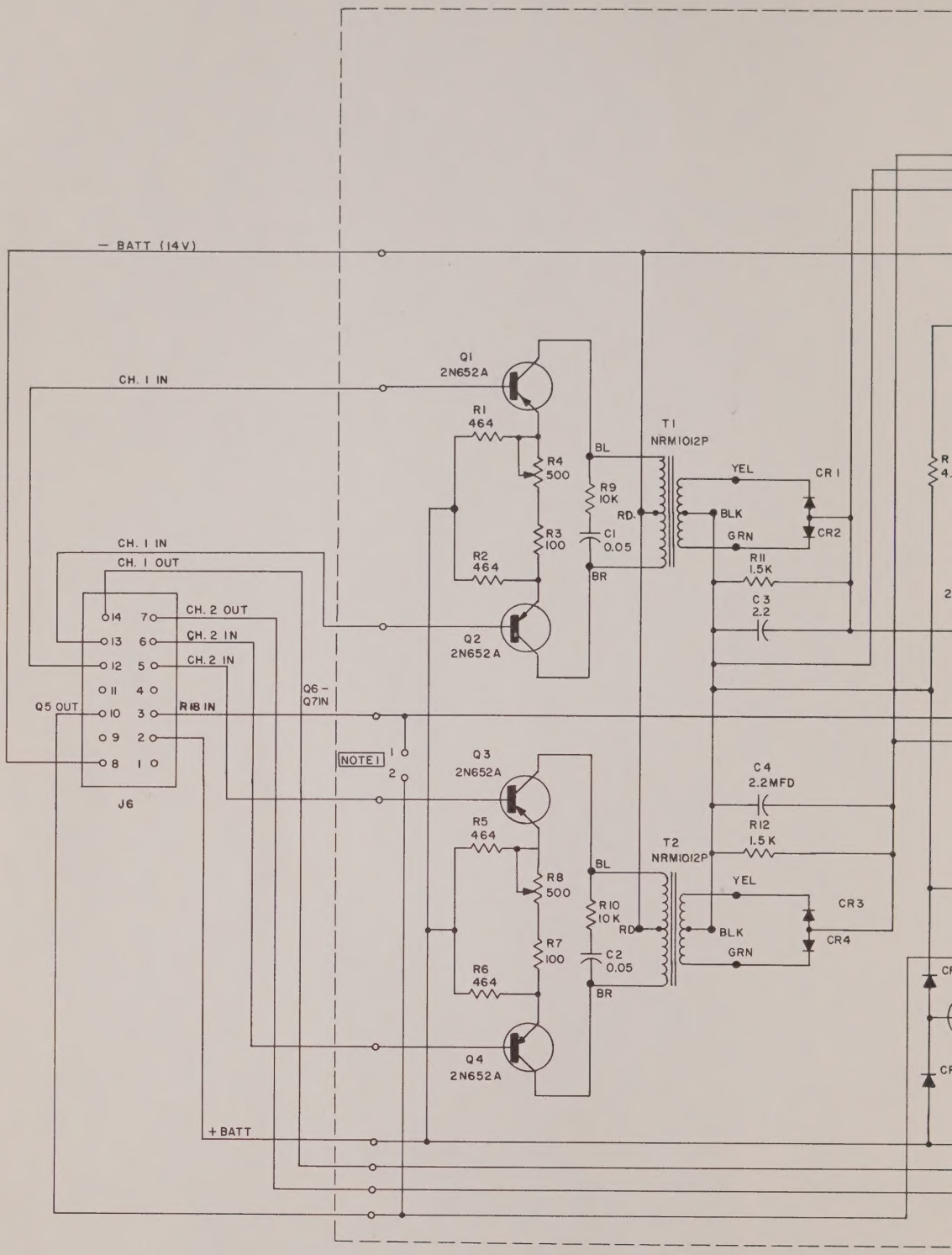


Figure 3 Diversity Combiner Type 234 Model 2C, Schematic Diagram


– BATT (14V)
CH. 1 IN
Q1
2N652A
R1
464
R4
500
R3
100
R2
464
R9
10K
C1
0.05
T1
NRM1012P
BL
RD.
BR
YEL
BLK
GRN
CR1
CR2
R11
1.5K
C3
2.2
CH. 1 IN
CH. 1 OUT
CH. 2 OUT
CH. 2 IN
CH. 2 IN
J6
14 7
13 6
12 5
11 4
10 3
9 2
8 1
Q5 OUT
R18 IN
Q6 – Q7 IN
Q2
2N652A
NOTE 1
1
2
Q3
2N652A
R5
464
R8
500
R7
100
R6
464
R10
10K
C2
0.05
T2
NRM1012P
C4
2.2MFD
R12
1.5K
CR3
CR4
Q4
2N652A
+ BATT

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